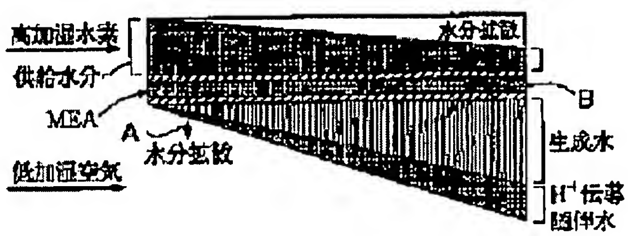
SOLID HIGH MOLECULAR FUEL CELL

Publication number: JP9283162
Publication date: 1997-10-31
Inventor: HASEGAWA YASUAKI; WATANABE SHOGO
Applicant: MAZDA MOTOR
Classification:
- international: ***H01M8/02; H01M8/04; H01M8/10;*** **H01M8/02; H01M8/04; H01M8/10;** (IPC1-7): H01M8/02; H01M8/04; H01M8/10
- European:
Application number: JP19960090750 19960412
Priority number(s): JP19960090750 19960412

Abstract of **JP9283162**

PROBLEM TO BE SOLVED: To suppress the increasing of a size and heighten fuel cell performance by properly conducting the feed and discharge control of the water content of the whole fuel cell. SOLUTION: A fuel cell is provided with an electrolyte film-electrode junction body which is composed of a solid molecule electrolyte film, an anode electrode arranged on one side thereof and a cathode electrode arranged on the other side thereof, an anode gas path which feeds anode side gas to one side of the electrolyte film-electrode junction body, and a cathode gas path which feeds cathode side gas to the other side of the electrolyte film-electrode junction body. The anode gas path and the cathode gas path are provided in a position relation such as confronting each other sandwiching the electrolyte film-electrode junction body so that the anode gas and the cathode gas flow respectively in the paths in parallel.



JAPANESE [JP,09-283162,A]

CLAIMS DETAILED DESCRIPTION TECHNICAL FIELD PRIOR ART EFFECT OF THE INVENTION TECHNICAL PROBLEM MEANS EXAMPLE DESCRIPTION OF DRAWINGS DRAWINGS

[Translation done.]

CLAIMS

[Claim(s)]
[Claim 1] The electrolyte membrane-electrode zygote which consists of the solid-state polyelectrolyte film, an anode electrode arranged at this one solid-state polyelectrolyte film side, and a cathode electrode arranged at an another side side, The anode gas path for supplying anode side gas to this one electrolyte membrane-electrode zygote side, In the polymer electrolyte fuel cell equipped with the cathode gas passageway for supplying cathode side gas to the another side side of said electrolyte membrane-electrode zygote The polymer electrolyte fuel cell characterized by being constituted so that it may be prepared by the physical relationship against which said anode gas path and cathode gas passageway stand face to face on both sides of said electrolyte membrane-electrode zygote and anode gas and cathode gas may circulate the inside of each path in parallel.
[Claim 2] In claim 1 said electrolyte membrane-electrode zygote While being the film of a rectangle configuration mostly and establishing the entrance to each path of the above-mentioned anode gas and cathode gas in the diagonal location of the above-mentioned electrolyte membrane-electrode zygote in plane view Said anode gas path and cathode gas passageway are formed so that the shape of a spiral may be drawn and it may extend from each inlet port on said electrolyte membrane-electrode zygote. This anode and a cathode gas passageway are a polymer electrolyte fuel cell characterized by being reversed on the way, drawing the shape of a spiral, and being open for free passage to each outlet.
[Claim 3] It is the polymer electrolyte fuel cell characterized by extending said anode gas path and cathode gas passageway winding from each inlet port on said electrolyte membrane-electrode zygote while said electrolyte membrane-electrode zygote is the film of a rectangle configuration mostly in claim 1 and the entrance to each path of the above-mentioned anode gas and cathode gas is established in the diagonal location of the above-mentioned electrolyte membrane-electrode zygote in plane view, and being open for free passage to each outlet.
[Claim 4] It is the polymer electrolyte fuel cell which is independently equipped with an anode gas humidification means to humidify anode gas, and a cathode gas humidification means to humidify cathode gas, in claim 1, respectively, and is characterized by the above-mentioned anode gas humidification means operating so that the humidity of anode gas may become high relatively rather than the humidity of cathode gas.

[Claim 5] The polymer electrolyte fuel cell characterized by coming to humidify so that anode gas may be in a supersaturation condition in claims 1 or 4, when said anode gas humidification means forms a Myst-like moisture supply means in an anode gas path.
[Claim 6] The polymer electrolyte fuel cell characterized by the thickness of said solid-state polyelectrolyte film being about 50 micrometers or less in claim 1.
[Claim 7] The solid-state polyelectrolyte film and the anode gas path for supplying anode side gas to this one solid-state macromolecule electrolysis film side, The cathode gas passageway for supplying cathode side gas to the another side side of said solid-state polyelectrolyte film, It has an anode gas humidification means to humidify anode gas, and a cathode gas humidification means to humidify cathode gas. The above-mentioned anode gas humidification means The polymer electrolyte fuel cell characterized by humidifying so that anode gas may be in a supersaturation condition by forming a Myst-like moisture supply means in an anode gas path, and operating so that the humidity of anode gas may become high relatively rather than the humidity of cathode gas.
[Claim 8] The polymer electrolyte fuel cell characterized by maintaining the water temperature of the anode side humidification section to temperature higher than the temperature inside a fuel cell in claim 7.
[Claim 9] The polymer electrolyte fuel cell characterized by increasing the circulating load of anode gas 2 to 10 times of the amount of stoichiometries required for electrode reaction in claim 7.
[Claim 10] The polymer electrolyte fuel cell characterized by increasing the amount of supply of the moisture to anode gas in a low loading field in claim 7 thru/or 9.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to a polymer electrolyte fuel cell.
[0002]
[Description of the Prior Art] A polymer electrolyte fuel cell has the structure which carried out the laminating of the gas separation member which forms the gas passageway for supplying each reactant gas, and which both supports a cel from both sides to the electrode surface of the generation-of-electrical-energy component (cel), i.e., a solid-state polyelectrolyte film-electrode zygote, constituted by generally putting the solid-state giant molecule of hydrogen ion conductivity by the carbon electrode which supported the platinum catalyst. And fuel gas, such as hydrogen gas, is supplied to one electrode, oxidant gas, such as oxygen or air, is supplied to the electrode of another side, and the chemical energy concerning the oxidation reduction reaction of fuel gas is extracted as direct electrical energy. In this case, the fuel cell constituted by carrying out the laminating of the cel as mentioned above is equipped with the gas passageway prolonged in the direction of a laminating of a cel for the gas supply to the electrode surface of each cel, and the gas passageway prolonged in this direction of a cel laminating constitutes gas supply opening to the gas passageway on the electrode surface of each cel, and the gas exhaust from the gas passageway on this electrode surface. Supply of this gas and an exhaust port are prepared near the edge of a cel. And reactant gas is in the condition isolated with the electrode, and it circulates each electrode surface top, performing oxidation and a reduction reaction by the each side of an electrode.
[0003] The fuel cell constituted so that it might flow in the direction in which JP,5-94831,A and the hydrogen which circulates one electrode surface top, and the oxygen which circulates the field of the opposite side cross at right angles is indicated. The flow pattern in each electrode surface of reactant gas is known also besides being indicated by the above-mentioned official report. An electron can be moved through an external load at a cathode side into each cel which constitutes a fuel cell, and the electrical energy by a series of electrochemical reaction which reacts with oxygen and generates water can be taken out. In the solid-state polyelectrolyte film, since a hydrogen ion moves, if the solid-state polyelectrolyte film dries, ionic conductivity will fall and an energy conversion efficiency will fall.

Therefore, in order to maintain good ionic conduction, it is necessary to supply moisture to the solid-state polyelectrolyte film.
[0004]
[Problem(s) to be Solved] In the conventional polymer electrolyte fuel cell, in order to maintain a high reaction rate, the humidification equipment formed in the exterior of the cel which electrode reaction produces chiefly performs supply of the above-mentioned moisture. However, enlargement of equipment is not escaped with the configuration made to depend for humidification of reactant gas on humidification equipment chiefly. As mentioned above, in a fuel cell, although moisture is needed by both by the side of an anode electrode and a cathode electrode, by the cathode electrode side, water generates according to electrode reaction. Since subsequent cathode electrode reaction will be checked if this generation water stops at an electrode surface as it is, it is necessary to eliminate from an electrode surface with a suitable means. On the other hand, in an anode electrode side, in order to make electrode reaction continue proper, it is necessary to maintain hydrogen gas to a damp or wet condition. At the former, there is nothing that coped with control of moisture in total in the system of such a whole fuel cell. This invention aims at aiming at improvement in the engine performance of a fuel cell by having consisted of such viewpoints and performing feeding-and-discarding control of the moisture of the whole fuel cell proper, controlling enlargement of equipment.
[0005]
[Means for Solving the Problem] In order to attain the above-mentioned purpose, this invention is constituted as follows. Namely, the polymer electrolyte fuel cell concerning this invention The electrolyte membrane-electrode zygote which consists of the solid-state polyelectrolyte film, an anode electrode arranged at this one solid-state polyelectrolyte film side, and a cathode electrode arranged at an another side side, The anode gas path for supplying anode side gas to this one electrolyte membrane-electrode zygote side, In the polymer electrolyte fuel cell equipped with the cathode gas passageway for supplying cathode side gas to the another side side of said electrolyte membrane-electrode zygote It is characterized by constituting so that it may be prepared by the physical relationship against which said anode gas path and cathode gas passageway stand face to face on both sides of said solid-state polyelectrolyte film and anode gas and cathode gas may circulate the inside of each path in parallel. In this case, while said electrolyte membrane-electrode zygote is the film of a rectangle configuration mostly and the entrance to each path of the above-mentioned anode gas and cathode gas is established in the diagonal location of the above-mentioned electrolyte membrane-electrode zygote in plane view Said anode gas path and cathode gas passageway are formed so that the shape of a spiral may be drawn and it may extend from each inlet port on said electrolyte membrane-electrode zygote, and as for this anode and a cathode gas passageway, it is desirable that it is reversed on the way, draw the shape of a spiral, and it is open for free passage to each outlet.
[0006] Furthermore, said electrolyte membrane-electrode zygote is the film of a rectangle configuration mostly, and while the entrance to each path of the above-

mentioned anode gas and cathode gas is established in the diagonal location of the above-mentioned electrolyte membrane-electrode zygote in plane view, in another mode, said anode gas path and cathode gas passageway are prolonged, winding from each inlet port on said electrolyte membrane-electrode zygote, and can make each outlet open for free passage in it. Furthermore, according to the description of this invention, it has independently an anode gas humidification means to humidify anode gas, and a cathode gas humidification means to humidify cathode gas, respectively, and the above-mentioned anode gas humidification means operates so that the humidity of anode gas may become high relatively rather than the humidity of cathode gas. When said anode gas humidification means forms a Myst-like moisture supply means in an anode gas path, you may make it humidify so that anode gas may be in a supersaturation condition.
[0007] It consists of desirable modes so that the thickness of said solid-state polyelectrolyte film may be set to about 50 micrometers or less. The anode gas path for supplying anode side gas to this one solid-state polyelectrolyte film and solid-state macromolecule electrolysis film side according to description that this invention is still more nearly another, The cathode gas passageway for supplying cathode side gas to the another side side of said solid-state polyelectrolyte film, It has an anode gas humidification means to humidify anode gas, and a cathode gas humidification means to humidify cathode gas. The above-mentioned anode gas humidification means By forming a Myst-like moisture supply means in an anode gas path, it humidifies so that anode gas may be in a supersaturation condition, and it operates so that the humidity of anode gas may become high relatively rather than the humidity of cathode gas. Moreover, you may make it maintain the water temperature of the anode side humidification section to temperature higher than the temperature inside a fuel cell. Moreover, you may make it secure the damp or wet condition by the side of a desired anode electrode by increasing the circulating load of anode gas 2 to 10 times of the amount of stoichiometries required for electrode reaction.
[0008] In a desirable mode, the amount of supply of the moisture to anode gas is increased in a low loading field.
[0009]
[Embodiment of the Invention] In order to keep good hydrogen ion conduction of the macromolecule electrolysis film as described above, and to maintain the activity of electrochemical reaction highly, it is necessary to make humidity of distributed gas high. According to the 1st description of this invention, in order to secure desired moisture to an anode electrode side, it constitutes so that the generation water generated in the cathode electrode side may be moved to an anode electrode side using the permeability of the solid-state polyelectrolyte film. While being able to make moisture react to reactant gas smoothly by supplying by the anode electrode side by this, in a cathode electrode side, there is effectiveness of killing two birds with one stone that generation water can be eliminated effectively. According to the 2nd description of this invention, to an anode electrode side, it constitutes so that a lot of moisture may be supplied as compared with a cathode electrode side. Various modes can be considered in order to realize this. It is maintaining more highly than a cathode gas passageway the

temperature of forming direct humidification means, such as a direct supersonic humidifier, in an anode gas path, increasing the absolute magnitude of the moisture in anode gas by increasing the circulating load of anode gas, and an anode gas path, and securing a high humidity condition etc. Thus, by controlling the moisture content by the side of an anode electrode and a cathode electrode, high labile can be maintained and the fuel cell engine performance can be raised.
[0010]
[Example] Hereafter, the example of this invention is explained. The block chart of the fuel cell system 10 which can apply this invention is shown in drawing 1 . In this example, hydrogen is used as anode gas and air is used as cathode gas. Hydrogen gas is stored in the hydrogen storage tank 11, is introduced into the post-humidification equipment 14 controlled by the predetermined pressure and the predetermined flow rate via the flow rate and the pressure controller 13 from this hydrogen storage tank 11, and is introduced into the polymer electrolyte fuel cell 1 concerning this invention after that. Moreover, air is compressed by the air compressor 15, is introduced into humidification equipment 17 via a flow rate and a pressure controller 16 like hydrogen gas, and is introduced into the interior of the humidified back fuel cell 1. And in the fuel cell 1 of stack structure, the pump 18 for cooling water for supplying cooling water through the humidification section 17 is formed. And a radiator 19 is formed in the outlet side of a fuel cell 1.
[0011] Furthermore, in order to enable it to control the supply temperature of the water to the humidification section, the Rhine heaters 22 and 23 are formed in Rhine 20 and 21, respectively. Furthermore, the fuel cell system 10 of this example is equipped with the water tank 24, this water tank 24 is built into each water Rhine 21 and 22, and the water tank 24 is common to the water supply system of the humidifier by the side of an anode and a cathode. Predetermined temperature was controlled by the heater 25 and the water temperature in a water tank 24 is come at it. The air from a fuel cell is exhausted, after a water condenser's 26 removing moisture and carrying out a pressure drop to a predetermined pressure by the pressure control valve 27. On the other hand, after circulating through the inside of a fuel cell, the hydrogen gas discharged from this cell is introduced into the hydrogen circulating pump 28, is introduced into a flow rate and a pressure controller 13, and is again introduced into a fuel cell 1. Reference of drawing 2 shows the explanatory view showing the structure and the working principle of a generation-of-electrical-energy component ******** cel of this example. [of a fuel cell] in drawing 2 , the generation of electrical energy component (a cel) 1 used as the configuration unit of the fuel cell of this example have basic structure equipped with the oxidation electrode 3 , i.e. , an anode electrode , with which the solid-state polyelectrolyte film 2 be supply to the hydrogen as a fuel in preparation for a center at the side of one of these , and the reduction pole 4 , i.e. , a cathode electrode , the air as a source of oxygen for a reduction reaction be supply to an another side side at a pole .
[0012] The anode electrode 3 is constituted by carrying out the laminating of the catalyst bed 33 to diffusion layer 32 pan, and joining to it to the inside, at the carbon cross 31 and its inside. And the fluting gas division plate 30 which has the current collection function of the power which gas separated and generated is

formed in the outside of the anode electrode 3. And an anode electrode side zygote consists of an anode electrode 3 and a fluting gas division plate 30. For the fluting gas division plate 30, the hydrogen gas which is fuel gas about the interior is proton H+. It has the slot for forming the anode gas path 34 which circulates supplying an electrolyte membrane side. The field contact section with the diffusion layer 32 of the carbon cross 31 constitutes the current collection section which collects the electron generated from a hydrogen content child. The cathode electrode side also has same composition and it has the laminating junction structure of the carbon cross 41, a diffusion layer 42, and a catalyst bed 43. And the outside of the carbon cross 41 is equipped with the fluting gas division plate 40, and it has the role which dissociates so that gas may not carry out the short pass of the slot which extends oxygen gas being crooked in a carbon cross front face again so that there may be no leakage appearance in the exterior.

[0013] And the fluting gas division plate 40 is proton H+ from an electrolyte membrane side. It has the slot which has a depth of about 1mm which forms the cathode gas passageway 44 which circulates the oxygen which contacts and generates water. And a cathode lateral electrode zygote consists of a cathode electrode 4 and a fluting gas division plate 40. (The proton, i.e., H+, which has moved through an electrolyte membrane 2 from the anode side as the above-mentioned configuration shows to drawing 2 notionally It is combined by the cathode electrode side with the electron which is collected in the anode electrode 3, does external work, and is supplied to the cathode electrode 4 via an external circuit.) That is, it is proton H+ by depriving a hydrogen content child of an electron in an anode electrode side. Proton H+ which was generated and was conducted through the electrolyte membrane 2 in the cathode electrode side The electron from the external circuit which has an external load, and the oxygen molecule supplied from a cathode gas passageway react, and a water molecule generates. Reference of drawing 3 shows the gas-passageway pattern in the cel 1 concerning this invention with the gestalt of a top view. The polymer electrolyte fuel cell of this example is equipped with the anode gas path for supplying anode side gas to this one electrolyte membrane-electrode zygote side, and the cathode gas passageway for supplying cathode side gas to the another side side of said electrolyte membrane-electrode zygote while the electrolyte membrane-electrode zygote which consists of the solid-state polyelectrolyte film, an anode electrode arranged at this one solid-state polyelectrolyte film side, and a cathode electrode arranged at an another side side is constituted. And the anode gas path and the cathode gas passageway are prepared by the physical relationship which confronts each other on both sides of said solid-state polyelectrolyte film. And in the cel 1 of this example, anode gas and cathode gas have the structure of flowing the inside of each path in parallel on both sides of an electrolyte membrane-electrode zygote. While this electrolyte membrane-electrode zygote has constituted the rectangle configuration mostly and the inlet ports 50 and 51 and outlets 52 and 53 of hydrogen gas and air are established in the diagonal location of the above-mentioned electrolyte membrane-electrode zygote in plane view, on said electrolyte membrane-electrode zygote, from each inlet port 50 and 51, said anode gas paths 54 and 55 and cathode gas passageway drew the shape of a spiral, and

are prolonged. And in this example, mostly, it was reversed, and this hydrogen gas and air ducts 54 and 55 drew the shape of a spiral in the center section of the electrolyte membrane-electrode zygote, and are prolonged toward each outlet 52 and 53.
[0014] Reference of drawing 4 shows another gas-passageway pattern. also in this example, like the above-mentioned example, the hydrogen gas passagewaies 54 and 55 and an air duct have relation which confront each other on both sides of an electrolyte membrane-electrode zygote, and the gas which boil, respectively and can be set be the same [the air duct] at the point that the entrances 50, 51, 52, and 53 of gas be also establish in the diagonal location of the electrolyte membrane-electrode zygote on a rectangle while they flow in parallel. However, moving in a zigzag direction right and left in drawing, from the upper part, it went caudad and the gas-passageway pattern of this example is prolonged. As shown in drawing 3 and drawing 4 , according to this invention, both the reactant gas paths 54 and 55 are the physical relationship which counters on both sides of an electrolyte membrane-electrode zygote, and both reactant gas flows in parallel on both sides of an electrolyte membrane-electrode zygote. Reference of drawing 5 shows notionally how the moisture content by the side of an anode electrode and a cathode electrode is missing from an outlet, and changes from the inlet port of gas. In drawing 5 , the upper part of an electrolyte membrane-electrode zygote shows the moisture change by the side of an anode electrode, and a lower part shows the moisture change by the side of a cathode electrode. The moisture content which accompanies the moisture by the side of a cathode electrode to hydrogen gas decreases gradually toward an outlet side from an entrance side. This reason is proton H+ at an anode electrode side. It is for moving to a cathode electrode side through an electrolyte membrane-electrode zygote with a water molecule. For this reason, in an anode electrode side, hydrogen gas is set up so that it may become higher than the moisture of the air by the side of a cathode electrode in an entrance side about a moisture content. Proton H+ which has moved with the cathode electrode on the other hand in the inside of an electrolyte membrane-electrode zygote The reduction reaction which the electron supplied from an external circuit combines occurs, and water generates in connection with this. For this reason, in a cathode electrode, a moisture content increases gradually according to air circulating toward an outlet side from an inlet port.
[0015] Therefore, moisture is consumed as reactant gas moves to an outlet side from an entrance side in an anode electrode side, and the material balance of the moisture of the whole fuel cell system after taking actuation of a cel into consideration is proton H+ from an anode side at a cathode electrode side. Moisture increases according to generating of the water by the migration and the reduction reaction of a water molecule accompanying migration. Therefore, at an anode electrode side, supply of water is needed and discharge of water becomes important by the cathode electrode side. After taking into consideration the mass transfer of the moisture which minds an electrolyte membrane-electrode zygote by this invention in view of this, the moisture control system of the whole fuel cell is established. According to one description of this invention, in parallel as, while confronting the passage of the air which is the source of supply of hydrogen gas

and oxygen gas as mentioned above on both sides of an electrolyte membrane-electrode zygote and constituting it, ring main consists of this inventions so that the mass transfer of the moisture by the side of an anode electrode and a cathode electrode may be promoted. Furthermore, by maintain the humidity of the anode gas introduce into a cel more highly than the humidity of cathode gas, in near the inlet port the concentration difference of moisture be give to the both sides of an electrolyte membrane-electrode zygote which have water permeability, and electrode reaction be advance so much, it constitute from this invention so that the spreading diffusion of the moisture from an anode gas path side to a cathode gas passageway side may be promote (see the arrow head A of drawing 5). Since moisture is consumed by the anode electrode side as mentioned above and moisture increases in a cathode electrode side as a reaction advances toward the outlet side of a path, near an outlet side, it will reverse with an entrance side and moisture will carry out spreading diffusion of the concentration difference of moisture toward an anode electrode side through an electrolyte membrane-electrode zygote from a cathode electrode side (see the arrow head B of drawing 5).

[0016] Therefore, since the moisture transfer which minds an electrolyte membrane-electrode zygote as mentioned above will be produced so that the concentration difference in a two-electrodes side may be canceled if the material balance of the above-mentioned moisture is considered as the whole system, the change inclination of a moisture content can be minimized covering the overall length of the continuous gas passageway through which it passes from an inlet port to which [of an anode electrode and a cathode electrode] side at an outlet side. Consequently, at an anode electrode side, the lack of moisture by consumption of the moisture in an outlet side is canceled, and the problem of the flooding by the increment in moisture can be effectively solved by the cathode electrode side. In order to maintain more highly than a cathode electrode side the moisture content by the side of an anode electrode, by this example, the temperature of the humidifier by the side of an anode electrode is operated at about 90 degrees C higher about 10 degrees C than the operating temperature (about 80 degrees C) of a cel. Since the amount of saturated steam in the hydrogen gas in 90 degrees C becomes twice [about] the amount of saturated steam in the hydrogen gas in 80 degrees C, it is effective to humidify the temperature of supply hydrogen gas in the condition of having maintained highly in order to make the company moisture content into a cel increase. Moreover, in another example, a company moisture content is increased by making the circulating load of hydrogen into 2 thru/or about 10 times and the sushi of the amount of theory required for a reaction, and about 1.5 or more usual times.

[0017] On the other hand, the humidity by the side of a cathode electrode is relatively stopped low rather than a cathode electrode side. For this purpose, the temperature by the side of a cathode electrode is controlled by this example at same about 80 degrees C as cel temperature. Moreover, in order to increase a reactant gas Nakamizu daily dose, a Myst generator like a supersonic humidifier is installed in a humidifier, and compulsorily, a steam can be introduced into distributed gas and can also be supplied in the state of supersaturation. Cel

potential can be raised in control of a pan and a moisture content, it being desirable to increase a moisture content in a low loading condition, and controlling polarization by this.

[0018]

[Effect of the Invention] While being able to perform moisture control in a compact in a solid-state macromolecule electrolysis film fuel cell according to this invention since the moisture content of both an anode electrode side and a cathode electrode was controlled using the permeability of the moisture of an electrolyte membrane-electrode zygote as described above, the generation water by the side of a cathode electrode can be processed to coincidence, and the generation-of-electrical-energy engine performance of a fuel cell can be maintained good. Furthermore, in this invention, since it was made to perform humidity of anode gas and cathode gas independently, respectively, the proper control corresponding to each need by the side of the anode electrode which has a different special feature, and a cathode electrode can be attained.

[Translation done.]

TECHNICAL FIELD

[Industrial Application] This invention relates to a polymer electrolyte fuel cell.

[Translation done.]

PRIOR ART

[Description of the Prior Art] A polymer electrolyte fuel cell has the structure which carried out the laminating of the gas separation member which forms the gas passageway for supplying each reactant gas, and which both supports a cel from both sides to the electrode surface of the generation-of-electrical-energy component (cel), i.e., a solid-state polyelectrolyte film-electrode zygote, constituted by generally putting the solid-state giant molecule of hydrogen ion conductivity by the carbon electrode which supported the platinum catalyst. And fuel gas, such as hydrogen gas, is supplied to one electrode, oxidant gas, such as oxygen or air, is supplied to the electrode of another side, and the chemical energy concerning the oxidation reduction reaction of fuel gas is extracted as direct electrical energy. In this case, the fuel cell constituted by carrying out the laminating of the cel as mentioned above is equipped with the gas passageway prolonged in the direction of a laminating of a cel for the gas supply to the electrode surface of each cel, and the gas passageway prolonged in this direction of a cel laminating constitutes gas supply opening to the gas passageway on the electrode surface of each cel, and the gas exhaust from the gas passageway on this electrode surface. Supply of this gas and an exhaust port are prepared near the edge of a cel. And reactant gas is in the condition isolated with the electrode, and it circulates each electrode surface top, performing oxidation and a reduction reaction by the each side of an electrode.
[0003] The fuel cell constituted so that it might flow in the direction in which JP,5-94831,A and the hydrogen which circulates one electrode surface top, and the oxygen which circulates the field of the opposite side cross at right angles is indicated. The flow pattern in each electrode surface of reactant gas is known also besides being indicated by the above-mentioned official report. An electron can be moved through an external load at a cathode side into each cel which constitutes a fuel cell, and the electrical energy by a series of electrochemical reaction which reacts with oxygen and generates water can be taken out. In the solid-state polyelectrolyte film, since a hydrogen ion moves, if the solid-state polyelectrolyte film dries, ionic conductivity will fall and an energy conversion efficiency will fall. Therefore, in order to maintain good ionic conduction, it is necessary to supply moisture to the solid-state polyelectrolyte film.

[Translation done.]

EFFECT OF THE INVENTION

[Effect of the Invention] While being able to perform moisture control in a compact in a solid-state macromolecule electrolysis film fuel cell according to this invention since the moisture content of both an anode electrode side and a cathode electrode was controlled using the permeability of the moisture of an electrolyte membrane-electrode zygote as described above, the generation water by the side of a cathode electrode can be processed to coincidence, and the generation-of-electrical-energy engine performance of a fuel cell can be maintained good. Furthermore, in this invention, since it was made to perform humidity of anode gas and cathode gas independently, respectively, the proper control corresponding to each need by the side of the anode electrode which has a different special feature, and a cathode electrode can be attained.

[Translation done.]

TECHNICAL PROBLEM

[Problem(s) to be Solved] In the conventional polymer electrolyte fuel cell, in order to maintain a high reaction rate, the humidification equipment formed in the exterior of the cel which electrode reaction produces chiefly performs supply of the above-mentioned moisture. However, enlargement of equipment is not escaped with the configuration made to depend for humidification of reactant gas on humidification equipment chiefly. As mentioned above, in a fuel cell, although moisture is needed by both by the side of an anode electrode and a cathode electrode, by the cathode electrode side, water generates according to electrode reaction. Since subsequent cathode electrode reaction will be checked if this generation water stops at an electrode surface as it is, it is necessary to eliminate from an electrode surface with a suitable means. On the other hand, in an anode electrode side, in order to make electrode reaction continue proper, it is necessary to maintain hydrogen gas to a damp or wet condition. At the former, there is nothing that coped with control of moisture in total in the system of such a whole fuel cell. This invention aims at aiming at improvement in the engine performance of a fuel cell by having consisted of such viewpoints and performing feeding-and-discarding control of the moisture of the whole fuel cell proper, controlling enlargement of equipment.

[Translation done.]

MEANS

[Means for Solving the Problem] In order to attain the above-mentioned purpose, this invention is constituted as follows. Namely, the polymer electrolyte fuel cell concerning this invention The electrolyte membrane-electrode zygote which consists of the solid-state polyelectrolyte film, an anode electrode arranged at this one solid-state polyelectrolyte film side, and a cathode electrode arranged at an another side side, The anode gas path for supplying anode side gas to this one electrolyte membrane-electrode zygote side, In the polymer electrolyte fuel cell equipped with the cathode gas passageway for supplying cathode side gas to the another side side of said electrolyte membrane-electrode zygote It is characterized by constituting so that it may be prepared by the physical relationship against which said anode gas path and cathode gas passageway stand face to face on both sides of said solid-state polyelectrolyte film and anode gas and cathode gas may circulate the inside of each path in parallel. In this case, while said electrolyte membrane-electrode zygote is the film of a rectangle configuration mostly and the entrance to each path of the above-mentioned anode gas and cathode gas is established in the diagonal location of the above-mentioned electrolyte membrane-electrode zygote in plane view Said anode gas path and cathode gas passageway are formed so that the shape of a spiral may be drawn and it may extend from each inlet port on said electrolyte membrane-electrode zygote, and as for this anode and a cathode gas passageway, it is desirable that it is reversed on the way, draw the shape of a spiral, and it is open for free passage to each outlet.
[0006] Furthermore, said electrolyte membrane-electrode zygote is the film of a rectangle configuration mostly, and while the entrance to each path of the above-mentioned anode gas and cathode gas is established in the diagonal location of the above-mentioned electrolyte membrane-electrode zygote in plane view, in another mode, said anode gas path and cathode gas passageway are prolonged, winding from each inlet port on said electrolyte membrane-electrode zygote, and can make each outlet open for free passage in it. Furthermore, according to the description of this invention, it has independently an anode gas humidification means to humidify anode gas, and a cathode gas humidification means to humidify cathode gas, respectively, and the above-mentioned anode gas humidification means operates so that the humidity of anode gas may become high relatively rather than the humidity of cathode gas. When said anode gas humidification means forms a

Myst-like moisture supply means in an anode gas path, you may make it humidify so that anode gas may be in a supersaturation condition.

[0007] It consists of desirable modes so that the thickness of said solid-state polyelectrolyte film may be set to about 50 micrometers or less. The anode gas path for supplying anode side gas to this one solid-state polyelectrolyte film and solid-state macromolecule electrolysis film side according to description that this invention is still more nearly another, The cathode gas passageway for supplying cathode side gas to the another side side of said solid-state polyelectrolyte film, It has an anode gas humidification means to humidify anode gas, and a cathode gas humidification means to humidify cathode gas. The above-mentioned anode gas humidification means By forming a Myst-like moisture supply means in an anode gas path, it humidifies so that anode gas may be in a supersaturation condition, and it operates so that the humidity of anode gas may become high relatively rather than the humidity of cathode gas. Moreover, you may make it maintain the water temperature of the anode side humidification section to temperature higher than the temperature inside a fuel cell. Moreover, you may make it secure the damp or wet condition by the side of a desired anode electrode by increasing the circulating load of anode gas 2 to 10 times of the amount of stoichiometries required for electrode reaction.

[0008] In a desirable mode, the amount of supply of the moisture to anode gas is increased in a low loading field.

[0009]

[Embodiment of the Invention] In order to keep good hydrogen ion conduction of the macromolecule electrolysis film as described above, and to maintain the activity of electrochemical reaction highly, it is necessary to make humidity of distributed gas high. According to the 1st description of this invention, in order to secure desired moisture to an anode electrode side, it constitutes so that the generation water generated in the cathode electrode side may be moved to an anode electrode side using the permeability of the solid-state polyelectrolyte film. While being able to make moisture react to reactant gas smoothly by supplying by the anode electrode side by this, in a cathode electrode side, there is effectiveness of killing two birds with one stone that generation water can be eliminated effectively. According to the 2nd description of this invention, to an anode electrode side, it constitutes so that a lot of moisture may be supplied as compared with a cathode electrode side. Various modes can be considered in order to realize this. It is maintaining more highly than a cathode gas passageway the temperature of forming direct humidification means, such as a direct supersonic humidifier, in an anode gas path, increasing the absolute magnitude of the moisture in anode gas by increasing the circulating load of anode gas, and an anode gas path, and securing a high humidity condition etc. Thus, by controlling the moisture content by the side of an anode electrode and a cathode electrode, high labile can be maintained and the fuel cell engine performance can be raised.

[Translation done.]

EXAMPLE

[Example] Hereafter, the example of this invention is explained. The block chart of the fuel cell system 10 which can apply this invention is shown in drawing 1 . In this example, hydrogen is used as anode gas and air is used as cathode gas. Hydrogen gas is stored in the hydrogen storage tank 11, is introduced into the post-humidification equipment 14 controlled by the predetermined pressure and the predetermined flow rate via the flow rate and the pressure controller 13 from this hydrogen storage tank 11, and is introduced into the polymer electrolyte fuel cell 1 concerning this invention after that. Moreover, air is compressed by the air compressor 15, is introduced into humidification equipment 17 via a flow rate and a pressure controller 16 like hydrogen gas, and is introduced into the interior of the humidified back fuel cell 1. And in the fuel cell 1 of stack structure, the pump 18 for cooling water for supplying cooling water through the humidification section 17 is formed. And a radiator 19 is formed in the outlet side of a fuel cell 1.
[0011] Furthermore, in order to enable it to control the supply temperature of the water to the humidification section, the Rhine heaters 22 and 23 are formed in Rhine 20 and 21, respectively. Furthermore, the fuel cell system 10 of this example is equipped with the water tank 24, this water tank 24 is built into each water Rhine 21 and 22, and the water tank 24 is common to the water supply system of the humidifier by the side of an anode and a cathode. Predetermined temperature was controlled by the heater 25 and the water temperature in a water tank 24 is come at it. The air from a fuel cell is exhausted, after a water condenser's 26 removing moisture and carrying out a pressure drop to a predetermined pressure by the pressure control valve 27. On the other hand, after circulating through the inside of a fuel cell, the hydrogen gas discharged from this cell is introduced into the hydrogen circulating pump 28, is introduced into a flow rate and a pressure controller 13, and is again introduced into a fuel cell 1. Reference of drawing 2 shows the explanatory view showing the structure and the working principle of a generation-of-electrical-energy component ******** cel of this example. [of a fuel cell] in drawing 2 , the generation of electrical energy component (a cel) 1 used as the configuration unit of the fuel cell of this example have basic structure equipped with the oxidation electrode 3 , i.e. , an anode electrode , with which the solid-state polyelectrolyte film 2 be supply to the hydrogen as a fuel in preparation for a center at the side of one of these , and the reduction pole 4 , i.e. , a cathode electrode , the air as a source of oxygen for a reduction reaction be supply to an

another side side at a pole .
[0012] The anode electrode 3 is constituted by carrying out the laminating of the catalyst bed 33 to diffusion layer 32 pan, and joining to it to the inside, at the carbon cross 31 and its inside. And the fluting gas division plate 30 which has the current collection function of the power which gas separated and generated is formed in the outside of the anode electrode 3. And an anode electrode side zygote consists of an anode electrode 3 and a fluting gas division plate 30. For the fluting gas division plate 30, the hydrogen gas which is fuel gas about the interior is proton H+. It has the slot for forming the anode gas path 34 which circulates supplying an electrolyte membrane side. The field contact section with the diffusion layer 32 of the carbon cross 31 constitutes the current collection section which collects the electron generated from a hydrogen content child. The cathode electrode side also has same composition and it has the laminating junction structure of the carbon cross 41, a diffusion layer 42, and a catalyst bed 43. And the outside of the carbon cross 41 is equipped with the fluting gas division plate 40, and it has the role which dissociates so that gas may not carry out the short pass of the slot which extends oxygen gas being crooked in a carbon cross front face again so that there may be no leakage appearance in the exterior.
[0013] And the fluting gas division plate 40 is proton H+ from an electrolyte membrane side. It has the slot which has a depth of about 1mm which forms the cathode gas passageway 44 which circulates the oxygen which contacts and generates water. And a cathode lateral electrode zygote consists of a cathode electrode 4 and a fluting gas division plate 40. (The proton, i.e., H+, which has moved through an electrolyte membrane 2 from the anode side as the above-mentioned configuration shows to drawing 2 notionally It is combined by the cathode electrode side with the electron which is collected in the anode electrode 3, does external work, and is supplied to the cathode electrode 4 via an external circuit.) That is, it is proton H+ by depriving a hydrogen content child of an electron in an anode electrode side. Proton H+ which was generated and was conducted through the electrolyte membrane 2 in the cathode electrode side The electron from the external circuit which has an external load, and the oxygen molecule supplied from a cathode gas passageway react, and a water molecule generates. Reference of drawing 3 shows the gas-passageway pattern in the cel 1 concerning this invention with the gestalt of a top view. The polymer electrolyte fuel cell of this example is equipped with the anode gas path for supplying anode side gas to this one electrolyte membrane-electrode zygote side, and the cathode gas passageway for supplying cathode side gas to the another side side of said electrolyte membrane-electrode zygote while the electrolyte membrane-electrode zygote which consists of the solid-state polyelectrolyte film, an anode electrode arranged at this one solid-state polyelectrolyte film side, and a cathode electrode arranged at an another side side is constituted. And the anode gas path and the cathode gas passageway are prepared by the physical relationship which confronts each other on both sides of said solid-state polyelectrolyte film. And in the cel 1 of this example, anode gas and cathode gas have the structure of flowing the inside of each path in parallel on both sides of an electrolyte membrane-electrode zygote. While this electrolyte membrane-electrode zygote has constituted the

rectangle configuration mostly and the inlet ports 50 and 51 and outlets 52 and 53 of hydrogen gas and air are established in the diagonal location of the above-mentioned electrolyte membrane-electrode zygote in plane view, on said electrolyte membrane-electrode zygote, from each inlet port 50 and 51, said anode gas paths 54 and 55 and cathode gas passageway drew the shape of a spiral, and are prolonged. And in this example, mostly, it was reversed, and this hydrogen gas and air ducts 54 and 55 drew the shape of a spiral in the center section of the electrolyte membrane-electrode zygote, and are prolonged toward each outlet 52 and 53.

[0014] Reference of drawing 4 shows another gas-passageway pattern. also in this example, like the above-mentioned example, the hydrogen gas passagewaies 54 and 55 and an air duct have relation which confront each other on both sides of an electrolyte membrane-electrode zygote, and the gas which boil, respectively and can be set be the same [the air duct] at the point that the entrances 50, 51, 52, and 53 of gas be also establish in the diagonal location of the electrolyte membrane-electrode zygote on a rectangle while they flow in parallel. However, moving in a zigzag direction right and left in drawing, from the upper part, it went caudad and the gas-passageway pattern of this example is prolonged. As shown in drawing 3 and drawing 4 , according to this invention, both the reactant gas paths 54 and 55 are the physical relationship which counters on both sides of an electrolyte membrane-electrode zygote, and both reactant gas flows in parallel on both sides of an electrolyte membrane-electrode zygote. Reference of drawing 5 shows notionally how the moisture content by the side of an anode electrode and a cathode electrode is missing from an outlet, and changes from the inlet port of gas. In drawing 5 , the upper part of an electrolyte membrane-electrode zygote shows the moisture change by the side of an anode electrode, and a lower part shows the moisture change by the side of a cathode electrode. The moisture content which accompanies the moisture by the side of a cathode electrode to hydrogen gas decreases gradually toward an outlet side from an entrance side. This reason is proton H+ at an anode electrode side. It is for moving to a cathode electrode side through an electrolyte membrane-electrode zygote with a water molecule. For this reason, in an anode electrode side, hydrogen gas is set up so that it may become higher than the moisture of the air by the side of a cathode electrode in an entrance side about a moisture content. Proton H+ which has moved with the cathode electrode on the other hand in the inside of an electrolyte membrane-electrode zygote The reduction reaction which the electron supplied from an external circuit combines occurs, and water generates in connection with this. For this reason, in a cathode electrode, a moisture content increases gradually according to air circulating toward an outlet side from an inlet port.

[0015] Therefore, moisture is consumed as reactant gas moves to an outlet side from an entrance side in an anode electrode side, and the material balance of the moisture of the whole fuel cell system after taking actuation of a cel into consideration is proton H+ from an anode side at a cathode electrode side. Moisture increases according to generating of the water by the migration and the reduction reaction of a water molecule accompanying migration. Therefore, at an anode electrode side, supply of water is needed and discharge of water becomes

important by the cathode electrode side. After taking into consideration the mass transfer of the moisture which minds an electrolyte membrane-electrode zygote by this invention in view of this, the moisture control system of the whole fuel cell is established. According to one description of this invention, in parallel as, while confronting the passage of the air which is the source of supply of hydrogen gas and oxygen gas as mentioned above on both sides of an electrolyte membrane-electrode zygote and constituting it, ring main consists of this inventions so that the mass transfer of the moisture by the side of an anode electrode and a cathode electrode may be promoted. Furthermore, by maintain the humidity of the anode gas introduce into a cel more highly than the humidity of cathode gas, in near the inlet port the concentration difference of moisture be give to the both sides of an electrolyte membrane-electrode zygote which have water permeability, and electrode reaction be advance so much, it constitute from this invention so that the spreading diffusion of the moisture from an anode gas path side to a cathode gas passageway side may be promote (see the arrow head A of drawing 5). Since moisture is consumed by the anode electrode side as mentioned above and moisture increases in a cathode electrode side as a reaction advances toward the outlet side of a path, near an outlet side, it will reverse with an entrance side and moisture will carry out spreading diffusion of the concentration difference of moisture toward an anode electrode side through an electrolyte membrane-electrode zygote from a cathode electrode side (see the arrow head B of drawing 5).

[0016] Therefore, since the moisture transfer which minds an electrolyte membrane-electrode zygote as mentioned above will be produced so that the concentration difference in a two-electrodes side may be canceled if the material balance of the above-mentioned moisture is considered as the whole system, the change inclination of a moisture content can be minimized covering the overall length of the continuous gas passageway through which it passes from an inlet port to which [of an anode electrode and a cathode electrode] side at an outlet side. Consequently, at an anode electrode side, the lack of moisture by consumption of the moisture in an outlet side is canceled, and the problem of the flooding by the increment in moisture can be effectively solved by the cathode electrode side. In order to maintain more highly than a cathode electrode side the moisture content by the side of an anode electrode, by this example, the temperature of the humidifier by the side of an anode electrode is operated at about 90 degrees C higher about 10 degrees C than the operating temperature (about 80 degrees C) of a cel. Since the amount of saturated steam in the hydrogen gas in 90 degrees C becomes twice [about] the amount of saturated steam in the hydrogen gas in 80 degrees C, it is effective to humidify the temperature of supply hydrogen gas in the condition of having maintained highly in order to make the company moisture content into a cel increase. Moreover, in another example, a company moisture content is increased by making the circulating load of hydrogen into 2 thru/or about 10 times and the sushi of the amount of theory required for a reaction, and about 1.5 or more usual times.

[0017] On the other hand, the humidity by the side of a cathode electrode is relatively stopped low rather than a cathode electrode side. For this purpose, the

temperature by the side of a cathode electrode is controlled by this example at same about 80 degrees C as cel temperature. Moreover, in order to increase a reactant gas Nakamizu daily dose, a Myst generator like a supersonic humidifier is installed in a humidifier, and compulsorily, a steam can be introduced into distributed gas and can also be supplied in the state of supersaturation. Cel potential can be raised in control of a pan and a moisture content, it being desirable to increase a moisture content in a low loading condition, and controlling polarization by this.

[Translation done.]

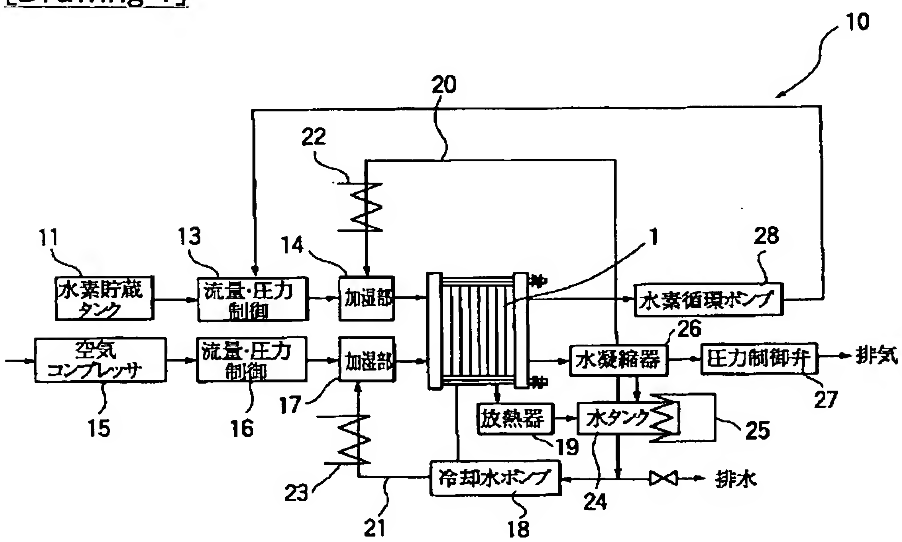
DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The block chart of the fuel cell control system which can apply this invention,
[Drawing 2] The outline sectional view showing the principle of operation of the electrolyte membrane-electrode zygote of the polymer electrolyte fuel cell concerning one example of this invention,
[Drawing 3] The top view showing the gas-passageway pattern in an electrolyte membrane-electrode zygote,
[Drawing 4] The top view showing another gas-passageway pattern of an electrolyte membrane-electrode zygote,
[Drawing 5] It is the conceptual diagram showing the change condition of the moisture content by the side of the anode electrode covering a gas-passageway overall length, and a cathode electrode.
[Description of Notations]
1 Polymer Electrolyte Fuel Cell
2 Solid-state Polyelectrolyte Film
3 Anode Electrode
4 Cathode Electrode
30 Fluting Gas Division Plate
31 Carbon Cross
32 Diffusion layer.

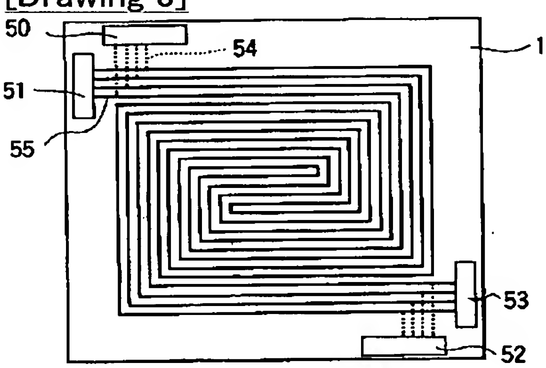
[Translation done.]

DRAWINGS

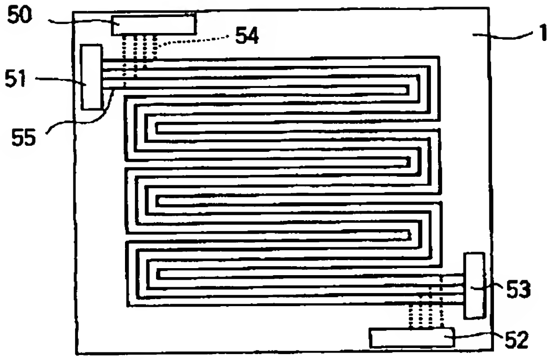
[Drawing 1]



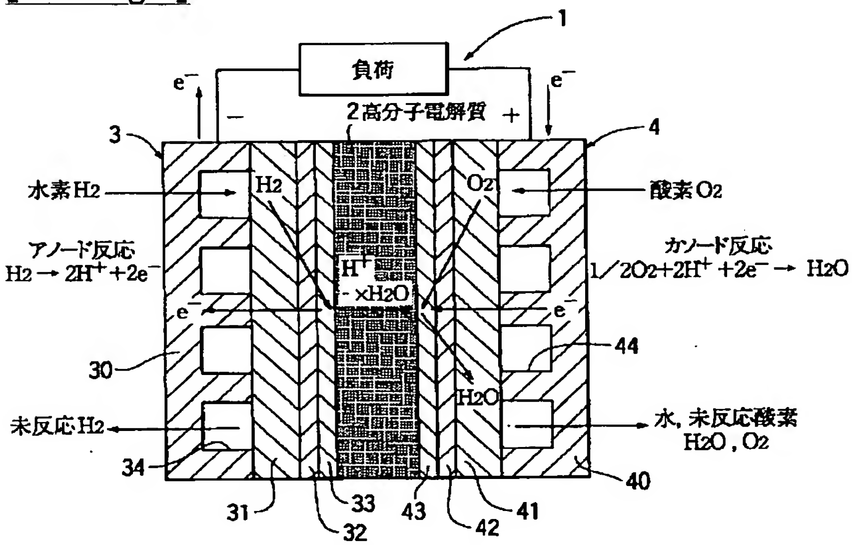
[Drawing 3]



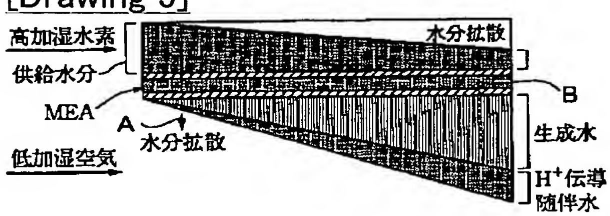
[Drawing 4]



[Drawing 2]



[Drawing 5]



[Translation done.]

(19)日本国特許庁（JP）　(12) 公開特許公報(A)　(11)特許出願公開番号

特開平9－283162

(43)公開日　平成9年(1997)10月31日

(51)Int.Cl.^{6}		識別記号	庁内整理番号	FI		技術表示箇所
H01M	8/02			H01M	8/02	R
						P
	8/04				8/04	K
						J
	8/10				8/10	

審査請求　未請求　請求項の数10　OL　（全 7 頁）

(21)出願番号　特願平8－90750

(22)出願日　平成8年(1996) 4月12日

(71)出願人　000003137
マツダ株式会社
広島県安芸郡府中町新地3番1号

(72)発明者　長谷川　泰明
広島県安芸郡府中町新地3番1号　マツダ株式会社内

(72)発明者　渡辺　正五
広島県安芸郡府中町新地3番1号　マツダ株式会社内

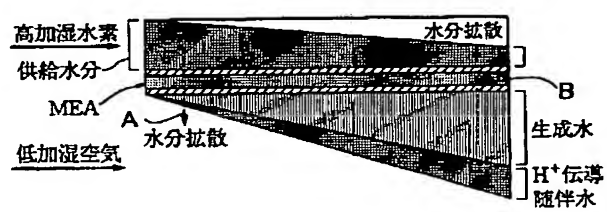
(74)代理人　弁理士　中村　稔　（外7名）

(54)【発明の名称】　固体高分子型燃料電池

(57)【要約】　（修正有）

【課題】燃料電池全体の水分の給排制御を適正に行ない、装置の大型化を抑制し、燃料電池の性能を高める。

【解決手段】固体分子電解質膜と、その一方の側に配置されるアノード電極と他方の側に配置されるカソード電極とからなる電解質膜－電極接合体と、該電解質膜－電極接合体の一方の側にアノード側ガスを供給するためのアノードガス通路と、前記電解質膜－電極接合体の他方の側にカソード側ガスを供給するためのカソードガス通路とを備えた固体高分子型燃料電池において、前記アノードガス通路とカソードガス通路とが前記電解質膜－電極接合体を挟んで対峙する位置関係で設けられ、かつアノードガスとカソードガスとがそれぞれ通路内を並行して流通するように構成された、固体高分子型燃料電池。



【特許請求の範囲】

【請求項１】　固体高分子電解質膜と、該固体高分子電解質膜の一方の側に配置されるアノード電極と他方の側に配置されるカソード電極とからなる電解質膜－電極接合体と、
該電解質膜－電極接合体の一方の側にアノード側ガスを供給するためのアノードガス通路と、
前記電解質膜－電極接合体の他方の側にカソード側ガスを供給するためのカソードガス通路とを備えた固体高分子型燃料電池において、
前記アノードガス通路とカソードガス通路とが前記電解質膜－電極接合体を挟んで対峙する位置関係で設けられ、かつアノードガスとカソードガスとがそれぞれの通路内を並行して流通するように構成されたことを特徴とする固体高分子型燃料電池。

【請求項２】　請求項１において、前記電解質膜－電極接合体は、ほぼ矩形形状の膜であって、
上記アノードガスとカソードガスの各通路に対する出入口が平面視において上記電解質膜－電極接合体の対角位置に設けられるとともに、
前記アノードガス通路とカソードガス通路は前記電解質膜－電極接合体上においてそれぞれの入口から螺旋状を描いて延びるように形成されており、該アノード及びカソードガス通路は途中で反転し、螺旋状を描いてそれぞれの出口に連通していることを特徴とする固体高分子型燃料電池。

【請求項３】　請求項１において、前記電解質膜－電極接合体は、ほぼ矩形形状の膜であって、
上記アノードガスとカソードガスの各通路に対する出入口が平面視において上記電解質膜－電極接合体の対角位置に設けられるとともに、
前記アノードガス通路とカソードガス通路は前記電解質膜－電極接合体上においてそれぞれの入口から蛇行しつつ延びてそれぞれの出口に連通していることを特徴とする固体高分子型燃料電池。

【請求項４】　請求項１において、アノードガスを加湿するアノードガス加湿手段と、
カソードガスを加湿するカソードガス加湿手段と、
をそれぞれ独立に備え、
上記アノードガス加湿手段はアノードガスの湿度がカソードガスの湿度よりも相対的に高くなるように動作することを特徴とする固体高分子型燃料電池。

【請求項５】　請求項１または４において、前記アノードガス加湿手段がアノードガス通路にミスト状の水分供給手段を設けることによってアノードガスが過飽和状態となるように加湿するようになったことを特徴とする固体高分子型燃料電池。

【請求項６】　請求項１において、前記固体高分子電解質膜の厚さが約５０μm以下であることを特徴とする固体高分子型燃料電池。

【請求項７】　固体高分子電解質膜と、
該固体高分子電解質膜の一方の側にアノード側ガスを供給するためのアノードガス通路と、
前記固体高分子電解質膜の他方の側にカソード側ガスを供給するためのカソードガス通路と、
アノードガスを加湿するアノードガス加湿手段と、
カソードガスを加湿するカソードガス加湿手段と、
を備え、
上記アノードガス加湿手段は、アノードガス通路にミスト状の水分供給手段を設けることによってアノードガスが過飽和状態となるように加湿して、アノードガスの湿度がカソードガスの湿度よりも相対的に高くなるように動作することを特徴とする固体高分子型燃料電池。

【請求項８】　請求項７において、アノード側加湿部の水温を燃料電池内部の温度より高い温度に維持することを特徴とする固体高分子型燃料電池。

【請求項９】　請求項７において、アノードガスの循環量を電極反応に必要な化学量論量の２～１０倍にすることを特徴とする固体高分子型燃料電池。

【請求項１０】　請求項７乃至９において、低負荷領域においてアノードガスへの水分の供給量を増大することを特徴とする固体高分子型燃料電池。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は、固体高分子型燃料電池に関する。

【０００２】

【従来の技術】固体高分子型燃料電池は、一般的に、水素イオン伝導性の固体高分子を白金触媒を担持したカーボン電極で挟み込んで構成される発電素子（セル）すなわち固体高分子電解質膜－電極接合体の電極面にそれぞれの反応ガスを供給するためのガス通路を画成するとともに、セルを両側から支持するガス分離部材とを積層した構造を有する。そして、一方の電極に水素ガス等の燃料ガスを供給し、他方の電極に酸素あるいは空気等の酸化剤ガスを供給して、燃料ガスの酸化還元反応にかかる化学エネルギーを直接電気エネルギーとして抽出するようになっている。この場合上記のようにセルが積層されることによって構成される燃料電池は、各セルの電極面へのガス供給のためにセルの積層方向に延びるガス通路を備えており、このセル積層方向に延びるガス通路は各セルの電極面上のガス通路へのガス供給口及び該電極面上のガス通路からのガス排出口を構成する。このガスの供給、排出口はセルの端部付近に設けられる。そして、反応ガスは電極によって隔離された状態で、電極のそれぞれの側で酸化及び還元反応を行いつつそれぞれの電極面上を流通するようになっている。

【０００３】特開平５－９４８３１号公報には、一方の電極面上を流通する水素とその反対側の面を流通する酸素が直交する方向に流れるように構成した燃料電池が開

示されている。反応ガスの各電極面での流れパターンは、上記公報に開示される以外にも知られている。燃料電池を構成する各セル内において、電子は、外部負荷を通ってカソード側に移動し、酸素と反応して水を生成する一連の電気化学反応による電気エネルギーを取り出すことができるものである。固体高分子電解質膜中では水素イオンが移動するため固体高分子電解質膜が乾燥してしまうと、イオン伝導率が低下し、エネルギー変換効率が低下してしまう。よって良好なイオン伝導を保つために固体高分子電解質膜に水分を供給する必要がある。

【０００４】

【解決しようとする課題】従来の固体高分子型燃料電池においては、高い反応速度を維持するために上記の水分の補給を専ら電極反応が生じるセルの外部に設けられた加湿装置によって行なうようになっている。しかし、反応ガスの加湿を加湿装置に専ら依存させる構成では、装置の大型化は免れない。上記のように燃料電池において、水分はアノード電極側、カソード電極側の両方で必要となるが、カソード電極側では、電極反応によって水が生成する。この生成水はそのまま電極面に止まるとその後のカソード電極反応を阻害するので、、適当な手段によって電極面から排除する必要がある。一方、アノード電極側では電極反応を適正に継続させるためには、水素ガスを湿潤状態に維持する必要がある。従来では、このような燃料電池の全体のシステムにおいて水分の制御をトータル的に対策したものはない。本発明はこのような観点で構成されたもので、燃料電池全体の水分の給排制御を適正に行なうことによって、装置の大型化を抑制しつつ燃料電池の性能の向上を図ることを目的としている。

【０００５】

【課題を解決するための手段】上記目的を達成するため、本発明は以下のように構成される。すなわち、本発明にかかる固体高分子型燃料電池は、固体高分子電解質膜と、該固体高分子電解質膜の一方の側に配置されるアノード電極と他方の側に配置されるカソード電極とからなる電解質膜－電極接合体と、該電解質膜－電極接合体の一方の側にアノード側ガスを供給するためのアノードガス通路と、前記電解質膜－電極接合体の他方の側にカソード側ガスを供給するためのカソードガス通路とを備えた固体高分子型燃料電池において、前記アノードガス通路とカソードガス通路とが前記固体高分子電解質膜を挟んで対峙する位置関係で設けられ、かつアノードガスとカソードガスとがそれぞれの通路内を並行して流通するように構成したことを特徴とする。この場合、前記電解質膜－電極接合体は、ほぼ矩形形状の膜であって、上記アノードガスとカソードガスの各通路に対する出入口が平面視において上記電解質膜－電極接合体の対角位置に設けられるとともに、前記アノードガス通路とカソードガス通路は前記電解質膜－電極接合体上においてそれぞれの入口から螺旋状を描いて延びるように形成されており、該アノード及びカソードガス通路は途中で反転し、螺旋状を描いてそれぞれの出口に連通しているのが好ましい。

【０００６】さらに、別の態様では、前記電解質膜－電極接合体は、ほぼ矩形形状の膜であって、上記アノードガスとカソードガスの各通路に対する出入口が平面視において上記電解質膜－電極接合体の対角位置に設けられるとともに、前記アノードガス通路とカソードガス通路は前記電解質膜－電極接合体上においてそれぞれの入口から蛇行しつつ延びてそれぞれの出口に連通させるようにすることもできる。さらに本発明の特徴によれば、アノードガスを加湿するアノードガス加湿手段と、カソードガスを加湿するカソードガス加湿手段と、をそれぞれ独立に備え、上記アノードガス加湿手段はアノードガスの湿度がカソードガスの湿度よりも相対的に高くなるように動作する。前記アノードガス加湿手段がアノードガス通路にミスト状の水分供給手段を設けることによってアノードガスが過飽和状態となるように加湿するようにしてもよい。

【０００７】好ましい態様では、前記固体高分子電解質膜の厚さが約５０μｍ以下となるように構成される。さらに本発明の別の特徴によれば、固体高分子電解質膜と、該固体高分子電解膜の一方の側にアノード側ガスを供給するためのアノードガス通路と、前記固体高分子電解質膜の他方の側にカソード側ガスを供給するためのカソードガス通路と、アノードガスを加湿するアノードガス加湿手段と、カソードガスを加湿するカソードガス加湿手段と、を備え、上記アノードガス加湿手段は、アノードガス通路にミスト状の水分供給手段を設けることによってアノードガスが過飽和状態となるように加湿して、アノードガスの湿度がカソードガスの湿度よりも相対的に高くなるように動作する。また、アノード側加湿部の水温を燃料電池内部の温度より高い温度に維持するようにしてもよい。また、アノードガスの循環量を電極反応に必要な化学量論量の２～１０倍にすることによって所望のアノード電極側の湿潤状態を確保するようにしても良い。

【０００８】好ましい態様では、低負荷領域においてアノードガスへの水分の供給量を増大するようになっている。

【０００９】

【発明の実施の形態】上記したように高分子電解膜の水素イオン伝導を良好に保ち、かつ電気化学反応の活性を高く維持するためには、供給ガスの湿度を高くする必要がある。本発明の第１の特徴によれば、アノード電極側において所望の水分を確保するためにカソード電極側で発生した生成水を固体高分子電解質膜の浸透性を利用してアノード電極側に移動させるように構成している。これによってアノード電極側では反応ガスに水分を供給し

て反応を円滑に行わせることができるとともに、カソード電極側では、有効に生成水を排除できるという、一石二鳥の効果がある。本発明の第２の特徴によれば、アノード電極側に対して、カソード電極側に比して多量の水分を補給するように構成している。これを実現するために様々な態様が考えられる。アノードガス通路に直接超音波加湿器等の直接加湿手段を設けること、アノードガスの循環量を増大させることによってアノードガス中の水分の絶対量を増大させること、アノードガス通路の温度をカソードガス通路よりも高く維持して高湿度状態を確保する等である。このようにアノード電極側及びカソード電極側の水分量を制御することにより高い反応活性を維持することができ、燃料電池性能を向上させることができるものである。

【００１０】

【実施例】以下、本発明の実施例について説明する。図１には、本発明を適用することができる燃料電池システム１０のブロックチャートが示されている。本例においては、アノードガスとして水素が用いられ、カソードガスとして空気が使用される。水素ガスは水素貯蔵タンク１１に貯蔵されており、該水素貯蔵タンク１１から流量・圧力制御装置１３を経由して所定の圧力、所定の流量に制御された後加湿装置１４に導入され、その後、本発明にかかる固体高分子型燃料電池１に導入されるようになっている。また、空気は、空気コンプレッサ１５によって圧縮され、水素ガスと同様に流量・圧力制御装置１６を経由して加湿装置１７に導入され、加湿された後燃料電池１の内部に導入されるようになっている。そして、スタック構造の燃料電池１内には、加湿部１７を介して冷却水を供給するための冷却水用ポンプ１８が設けられる。そして、燃料電池１の出口側には放熱器１９が設けられる。

【００１１】さらに、加湿部への水の供給温度を制御できるようにするためにライン２０、２１にラインヒータ２２、２３とがそれぞれ設けられる。さらに、本例の燃料電池システム１０は、水タンク２４を備えており、この水タンク２４はそれぞれの水ライン２１、２２に組み込まれており、水タンク２４はアノード側とカソード側の加湿器の水供給系に共通になっている。水タンク２４内の水温はヒータ２５によって所定温度の制御されるようになっている。燃料電池からの空気は、水凝縮器２６によって水分を除去し、かつ、圧力制御弁２７によって所定圧力まで圧力低下させた後、排気されるようになっている。一方、燃料電池内を循環した後、該電池から排出された水素ガスは、水素循環ポンプ２８に導入され、流量・圧力制御装置１３に導入されて、再び燃料電池１に導入されるようになっている。図２を参照すると、本例の燃料電池の発電素子すわなちセルの構造及び作動原理を示す説明図が示されている。図２において、本例の燃料電池の構成単位となる発電素子（セル）１は中央に固体高分子電解質膜２を備えその一方の側に燃料としての水素が供給される酸化電極すなわちアノード電極３、他方の側に還元反応用の酸素源としての空気が供給される還元極すなわちカソード電極４を備える基本構造になっている。

【００１２】アノード電極３は、カーボンクロス３１、その内側に拡散層３２さらにその内側に触媒層３３を積層して接合することによって構成されている。そして、アノード電極３の外側には、ガスの分離及び発電した電力の集電機能を有する溝付ガス分離板３０が設けられている。そして、アノード電極３と溝付ガス分離板３０とでアノード電極側接合体が構成される。溝付ガス分離板３０は、内部を燃料ガスである水素ガスがプロトンH^+を電解質膜側に供給しつつ流通するアノードガス通路３４を画成するための溝を備えている。カーボンクロス３１の拡散層３２との面接触部は、水素分子から発生する電子を集電する集電部を構成する。カソード電極側も同様な構成になっており、カーボンクロス４１、拡散層４２、触媒層４３の積層接合構造を有する。そしてカーボンクロス４１の外側には溝付ガス分離板４０を備えており、酸素ガスが外部に漏れ出ないようにまた、カーボンクロス表面を屈曲しつつ延びる溝をガスがショートパスしないように分離を行なう役割をもつ。

【００１３】そして、溝付ガス分離板４０は、電解質膜側からのプロトンH^+と接触して水を生成する酸素を流通させるカソードガス通路４４を画成する約１mm程度の深さを有する溝を有している。そして、カソード電極４と溝付ガス分離板４０とでカソード側電極接合体が構成される。上記構成によって図２に概念的に示すようにアノード側から電解質膜２を介して移動してきたプロトンすなわちH^+とアノード電極３において集電されて外部仕事をして外部回路を経由してカソード電極４に供給される電子とのカソード電極側で結合される。すなわちアノード電極側では、水素分子が電子を奪われることによってプロトンH^+が発生し、カソード電極側では、電解質膜２を介して伝導されたプロトンH^+と外部負荷を有する外部回路からの電子とカソードガス通路から供給される酸素分子とが反応して水分子が生成する。図３を参照すると、本発明にかかるセル１におけるガス通路パターンが平面図の形態で示されている。本例の固体高分子型燃料電池は、固体高分子電解質膜と、該固体高分子電解質膜の一方の側に配置されるアノード電極と他方の側に配置されるカソード電極とからなる電解質膜一電極接合体が構成されるとともに、該電解質膜一電極接合体の一方の側にアノード側ガスを供給するためのアノードガス通路と、前記電解質膜一電極接合体の他方の側にカソード側ガスを供給するためのカソードガス通路とを備えている。そして、アノードガス通路とカソードガス通路とは前記固体高分子電解質膜を挟んで対峙する位置関係で設けられている。そして、本例のセル１において

は、アノードガスとカソードガスとはそれぞれの通路内を電解質膜－電極接合体を挟んで並行して流れる構造になっている。該電解質膜－電極接合体は、ほぼ矩形形状を成しており、水素ガスと空気の入口５０、５１及び出口５２、５３が平面視において上記電解質膜－電極接合体の対角位置に設けられるとともに、前記アノードガス通路５４、５５とカソードガス通路は前記電解質膜－電極接合体上においてそれぞれの入口５０、５１から螺旋状を描いて延びている。そして、該水素ガス及び空気通路５４、５５は本例ではほぼ電解質膜－電極接合体の中央部において、反転して螺旋状を描いてそれぞれの出口５２、５３に向かって延びている。

【００１４】図４を参照すると、別のガス通路パターンが示されている。本例においても、上記の例と同様に、水素ガス通路５４、５５及び空気通路とは電解質膜－電極接合体を挟んで対峙する関係になっており、それぞれにおけるガスは並行に流れるようになっているとともに、ガスの出入口５０、５１、５２、５３も矩形上の電解質膜－電極接合体の対角位置に設けられる点で同じである。しかし本例のガス通路パターンは図において左右に蛇行しつつ上方から下方に向かって延びている。図３及び図４に示すように本発明によれば、両反応ガス通路５４、５５は、電解質膜－電極接合体を挟んで対向する位置関係になっており、両反応ガスは、電解質膜－電極接合体を挟んで並行に流れるようになっている。図５を参照すると、アノード電極側及びカソード電極側の水分量がガスの入口から出口にかけてどのように変化するかが概念的に示されている。図５において、電解質膜－電極接合体の上方がアノード電極側の水分変化を示し下方はカソード電極側の水分変化を示す。カソード電極側の水分は水素ガスに同伴する水分量は入口側から出口側に向かって徐々に減少する。この理由は、アノード電極側ではプロトンH^+が水分子を伴って電解質膜－電極接合体を介してカソード電極側に移動するためである。このためアノード電極側では、水素ガスを水分量を入口側においてカソード電極側の空気の水分よりも高くなるように設定する。一方、カソード電極では、電解質膜－電極接合体内を移動してきたプロトンH^+と外部回路から供給される電子とが結合する還元反応が起こり、これにともなって水が生成する。このためカソード電極では入口から出口側に向かって空気が流通するのに応じて、水分量は徐々に増大する。

【００１５】したがって、セルの動作を考慮した上での燃料電池システム全体の水分の物質収支は、アノード電極側では反応ガスが入口側から出口側に移動するにしたがって、水分が消費され、カソード電極側では、アノード側からのプロトンH^+の移動に伴う水分子の移動及び還元反応による水の発生によって水分が増加する。したがって、アノード電極側では、水の供給が必要となり、カソード電極側では水の排出が肝要となる。このことに鑑み、本発明では、電解質膜－電極接合体を介しての水分の物質移動を考慮した上で、燃料電池全体の水分制御システムを確立している。本発明の１つの特徴によれば、本発明では上記のように水素ガスと酸素ガスの供給源である空気の流路を電解質膜－電極接合体を挟んで対峙させて構成するとともに両ガスを並行して流すようにして、アノード電極側とカソード電極側との水分の物質移動が促進されるように構成している。さらに、本発明では、セルに導入されるアノードガスの湿度をカソードガスの湿度よりも高く維持することにより水浸透性を有する電解質膜－電極接合体の両側に水分の濃度差を与え電極反応がそれほど進行していない入口付近においては、アノードガス通路側からカソードガス通路側への水分の拡散移動が促進されるように構成している（図５の矢印Ａを参照）。通路の出口側に向かって反応が進行するにつれて、上記のようにアノード電極側では水分を消費し、カソード電極側では水分が増加するので、出口側付近では水分の濃度差は入口側と逆転し、電解質膜－電極接合体を介してカソード電極側からアノード電極側に向かって水分が拡散移動することとなる（図５の矢印Ｂを参照）。

【００１６】したがって、全体のシステムとして上記の水分の物質収支を考えると、上記のように電解質膜－電極接合体を介しての水分移動は両電極面における濃度差を解消するように生じるので、アノード電極及びカソード電極のいずれの側においても入口から出口側にへの連続したガス通路の全長にわたって水分量の変化勾配を最小化することができる。この結果、アノード電極側では、出口側における水分の消費による水分不足が解消され、カソード電極側では、水分増加によるフラッディングの問題を有効に解消することができる。アノード電極側の水分量をカソード電極側よりも高く維持するために、本例では、アノード電極側の加湿器の温度をセルの運転温度（約８０℃）よりも約１０℃高い約９０℃で運転する。９０℃における水素ガス中の飽和水蒸気量は８０℃における水素ガス中の飽和水蒸気量の約２倍となるので、供給水素ガスの温度を高く維持した状態で加湿することはセル内への同伴水分量を増加させるために有効である。また、別の例では、水素の循環量を反応に必要な理論量の２乃至１０倍程度とすし、通常の１．５倍程度以上とすることによって同伴水分量を増大させる。

【００１７】一方、カソード電極側の湿度はカソード電極側よりも相対的に低く抑える。この目的のために、本例では、カソード電極側の温度をセル温度と同じ約８０℃に制御する。また反応ガス中水分量を増大させるためにたとえば、超音波加湿器のようなミスト発生器を加湿器に設置し、強制的に水蒸気を供給ガスに導入して過飽和状態で供給することもできる。さら、水分量の制御において、低負荷状態において水分量を増大させることが好ましく、これによって分極を抑制しつつセル電位を高

めることができる。

【００１８】

【発明の効果】上記したように、本発明によれば、固体高分子電解膜燃料電池において、電解質膜－電極接合体の水分の浸透性を利用してアノード電極側及びカソード電極の両方の水分量を制御するようにしたので、水分制御をコンパクトに行なうことができるとともに、カソード電極側の生成水の処理を同時に行なうことができ、燃料電池の発電性能を良好に維持することができる。さらに、本発明では、アノードガスとカソードガスの湿度をそれぞれ独立して行なうようにしたので、異なる特質を有するアノード電極とカソード電極側のそれぞれの必要性に対応した適正な制御を達成することができる。

【図面の簡単な説明】

【図１】本発明を適用することができる燃料電池制御システムのブロックチャート、

【図２】本発明の１実施例にかかる固体高分子型燃料電池の電解質膜－電極接合体の動作原理を示す概略断面図、

【図３】電解質膜－電極接合体におけるガス流路パターンを示す平面図、

【図４】電解質膜－電極接合体の別のガス流路パターンを示す平面図、

【図５】ガス流路全長にわたるアノード電極側及びカソード電極側の水分量の変化状態を示す概念図である。

【符号の説明】

１　固体高分子型燃料電池

２　固体高分子電解質膜

３　アノード電極

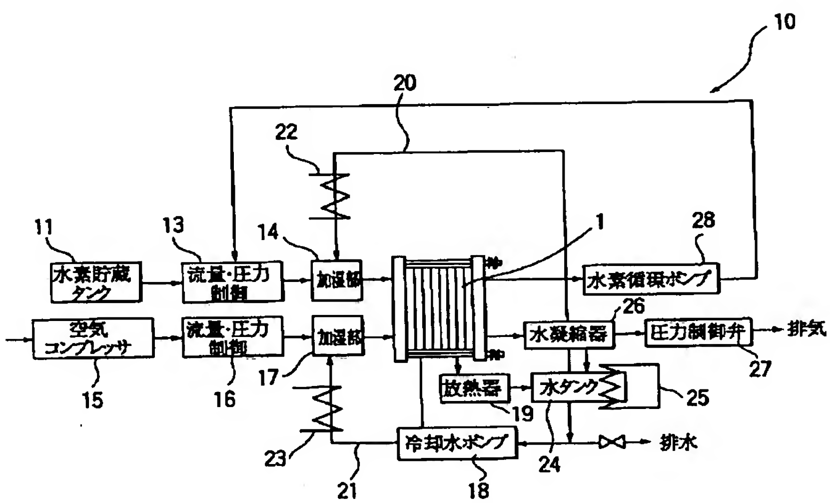
４　カソード電極

３０　溝付ガス分離板

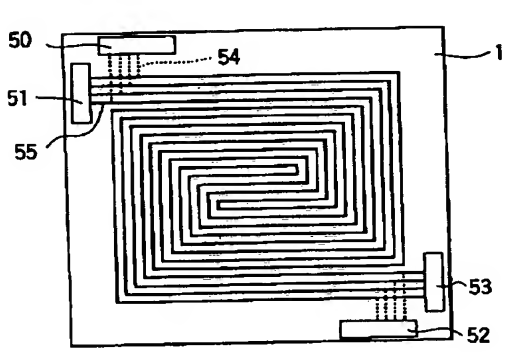
３１　カーボンクロス

３２　拡散層。

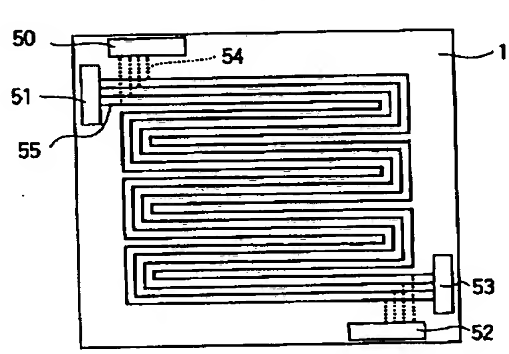
【図１】



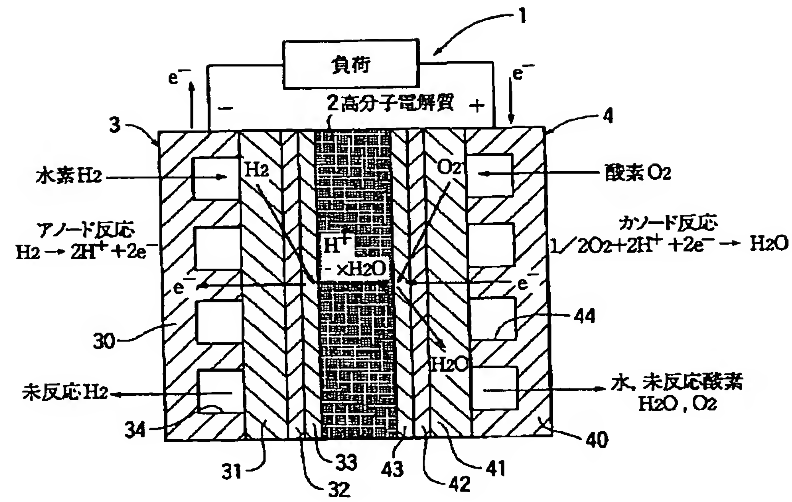
【図３】



【図４】

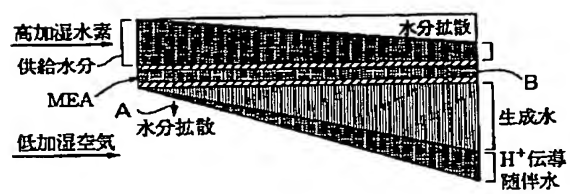


【図２】



1
負荷
e⁻
－
＋
2高分子電解質
3
4
水素H2
H2
O2
酸素O2
アノード反応
H2 → 2H⁺＋2e⁻
H⁺
・xH2O
カソード反応
1／2O2＋2H⁺＋2e⁻ → H2O
e⁻
44
30
H2O
未反応H2
水，未反応酸素
H2O，O2
34
40
31
32
33
43
42
41

【図５】



高加湿水素
水分拡散
供給水分
B
MEA
A
水分拡散
生成水
低加湿空気
H⁺伝導
随伴水